

Field of the Invention

The present invention relates to a vacuum boring and mud recovery container.

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Background of the Invention

Current state of the art vacuum boring and mud recovery systems, such as US 6,453,584 by the present inventor, have a vacuum container having a vacuum capable of boring and mud recovery and provide simultaneously, vacuum fill, store and dispense. However problems arise from the horizontally mounted debris tank when trying to dispose of the debris.

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The primary objective of the present invention is to provide a vacuum boring and mud recovery container having a fixed slope to allow a greater percentage of fill of the debris tank before the debris full level reaches the vacuum cut off valve, provides compact size, concentrated weight, efficient plumbing and debris to be emptied from the vacuum container by gravity when the access door is opened.

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Summary of the Invention

The above described objectives and others are met by a vacuum container mounted at a fixed slope and supported by a liquid water container. The fixed slope may be of sufficient angle to allow debris to be emptied from the vacuum container by gravity when the access door is opened. A filter housing may be mounted to and supported by the vacuum container. By flush mounting the clean out end of the filter housing with the clean out end of the vacuum container, a single access clean out door may be used to access both simultaneously. This compact design provides efficient interaction and plumbing between the water tank, vacuum tank and filter housing as well as concentrating weight and reducing floor space. Two parallel tubular support means may be added at the base of the above described unit and extended past the water container sufficient length to mount a support base for a power plant, which may consist of an engine, a vacuum producing means, a vacuum/blower, a water pump, a water jetter pump, a hydraulic pump and reservoir, an air compressor and air tank, an electric generator, a heater, controls, monitor, sensors, or a goose neck trailer coupler.

The above described unit may be efficiently and quickly convertible from a skid mount unit to a pick-up truck bed mounted unit secured by the goose neck ball located in the bed of a pick-up truck, converted to a forklift mounted unit or a skid steer mounted unit or be converted to a trailer mounted unit dependent on the users need for the days activity. A vibrating screen may be mounted by flexible connections on the inside of the vacuum container, preferably to the inside of the access door, to separate liquids from solids.

5 Liquid cleaning, purification or sterilizing means may be added within the vacuum container or be mounted to the exterior of the vacuum container for the purpose of pretreatment of the water as it is recycled. A liquid dispensed means, such as a pump, may dispense liquid from the vacuum container vibrating screen effluent through the desired pretreatment means and into the liquid holding container with or without
10 eliminating the vacuum within the vacuum container, thus recycling liquid for reuse. This technique allows the original liquid carried to a work site to be reused multiple times.

 The vacuum container may have a screw conveyor means attached so as to dispense solids from the vacuum container with or without eliminating the vacuum within
15 the vacuum container. An air nozzle means may be attached to the discharge orifice of the screw conveyor so as to further convey the solids by air. The air discharge from the vacuum-producing device may be utilized as the source of air supplied to the air nozzles for the purpose of conveying the solids dispensed by the screw conveyor. The air blower technique further improves efficiency and provides a compact system by using a single
20 air blower device to provide both a vacuum for the vacuum container and an air volume under pressure to convey the dispensed solids.

 A powered rotating, telescoping articulated boom with one or more arms, elbows and knuckles may be attached so as to convey through the boom conduit the air conveyed solids to a dispensing point of choice such as a dump truck bed or recycled back into a
25 ditch or hole from which it was removed. A cyclone may be attached to the end of the boom conduit to separate the solids from the air volume used to convey the solids.

5 The above described system may be stationary or mobile. Mobility may be obtained by mounting the system on a trailer, powered vehicle, truck, zero turn radius drivable vehicle, fork lift, skid steer, barge, or railcar.

 The above vacuum system is further empowered by vacuum hose end attachments, which may be applied so as to improve the vacuum ability of substances
10 such as dirt, gravel, asphalt, concrete, or surface cleaning such as hydrocarbons, rust, or paint. The above vacuum system processes wet and/or dry material, thus providing means to separate rust, paint chips, sand, dirt, or asphalt from liquids, and further remove hydrocarbons from water and sterilize the cleaned water if needed. The high pressure water pumps provide water to a wide variety of spray nozzles at a variety of pressures for
15 cleaning, cutting, emulsifying or demolition.

 Numerous other embodiments are also possible. These elements of the embodiments described herein can also be combined in other ways, or with other elements to create still further embodiments.

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Brief Description of Drawings

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which may be regarded as forming the present invention, it is believed that the invention will be better understood from the following description taken in conjunction with the accompanying drawings, in which:

10 Fig. 1 is a side view of a vacuum container mounted at a fixed slope according to a preferred embodiment of the invention.

Fig. 2 is a side view of the vacuum container unit of Fig. 1, arranged on the bed of a pick-up, according to an embodiment of the invention.

15 Fig. 3 is a side view of the vacuum container unit of Fig. 1, showing the solids/liquid separator and jetter water pump, according to an embodiment of the invention.

Fig. 4 is a side view of the vacuum container unit of Fig. 1, arranged on a skid steer according to an embodiment of the invention.

20 Fig. 5 is a side view of the vacuum container unit of Fig. 1, showing the rotating, articulating, telescoping, vacuum conduit boom, according to an embodiment of the invention.

Fig. 6 is a side view of the vacuum container unit of Fig. 1, arranged on a zero turn radius vehicle according to an embodiment of the invention.

25 Fig. 7 is a side view of the vacuum container unit of Fig. 1, showing the solids dispensing unit according to an embodiment of the invention..

Fig. 8 is a side view of the vacuum container unit of Fig. 1, arranged on a zero turn radius vehicle according to an embodiment of the invention.

5 Fig. 9 is a side view of the vacuum container unit of Fig. 1, arranged on a zero turn radius vehicle according to an embodiment of the invention.

 Fig. 10 is a side view of the vacuum container unit of Fig. 1, arranged on a trailer towed by a truck according to an embodiment of the invention.

 Fig. 11 is a side view of the vacuum container unit of Fig. 1 according to an
10 embodiment of the invention.

 Fig. 12 is a side view of the vacuum container unit of Fig. 1 arranged on a zero turn radius vehicle according to an embodiment of the invention.

 Fig. 13 is a side view of a vacuum container unit according to an embodiment of the invention.

15 Fig. 14 is a side view of an articulating jetter boom according to an embodiment of the invention.

 Fig. 15 is a side view of a vacuum container according to an embodiment of the invention.

 Fig. 16 is a side view of a vacuum container unit according to an embodiment of
20 the invention.

 Fig. 17 is a side view of a vacuum container unit according to an embodiment of the invention.

 Fig. 18 is a side view of a vacuum container unit arranged on a skid steer, according to an embodiment of the invention.

25 Fig. 19 is a side view of the vacuum container unit of Fig. 1 arranged on a zero turn radius vehicle, according to an embodiment of the invention.

5 Fig. 20 is a side view of the vacuum container unit of Fig. 1 arranged on a zero turn radius vehicle according to an embodiment of the invention.

 Fig. 21 is a side view of a vacuum container unit according to an embodiment of the invention.

 Fig. 22 is a side view of a vacuum container unit arranged on a zero turn radius
10 vehicle, according to an embodiment of the invention.

 Fig. 23 is a side view of a vacuum container unit according to an embodiment of the invention.

 Fig. 24 is a side view of the vacuum container unit of Fig. 1 according to an embodiment of the invention.

15 Fig. 25a is a plan view of a rotating head sprayer according to an embodiment of the invention.

 Fig. 25b is a side sectional view of a sprayer according to an embodiment of the invention.

 Fig. 26 is a side view of the vacuum conduit according to an embodiment of the
20 invention.

 Fig. 27a is a side view of a sound reduction muffler according to an embodiment of the invention.

 Fig. 27b is a side view of a sound reduction muffler according to an embodiment of the invention.

25 Fig. 28 is a cross sectional side view of a vacuum hose end according to an embodiment of the invention.

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Detailed Description of the Preferred Embodiment

Referring to Fig 1, a vacuum container (12) is mounted at a fixed slope and supported by a liquid water container (8). The fixed slope may be of sufficient angle to allow debris to empty by gravity when the access door (18) is opened. This arrangement creates a compact package unit, reduces floor space needed to contain both liquid container (8) and vacuum debris container (12) and condenses the weight of the water container (8) and vacuum debris container (12) combination. The dual container combination lends itself, by compactness, to use as a multifunctional convertible unit capable of being quickly converted from a skid mount unit (64) to a trailer mount unit, to a gooseneck hitch coupled (63) pick up truck bed unit, to a fork lift or skid steer transported unit. A filter housing (62) may be mounted piggyback onto the outer shell of the vacuum debris container (12) thus further compacting the space required for the system and again condensing weight and increasing the efficiency of interaction between the water tank (8), vacuum container (12) and filter housing (62). By flush mounting the clean out end of the filter housing (62) with the clean out access end of the vacuum container (12), a single door (18) may be utilized to access both vacuum container (12) and filter housing (62) simultaneously. A power plant (67) may consist of an engine, vacuum/blower, water pump, hydraulic pump, air compressor or electric generator and may be mounted with the vacuum tank and water tank. A hose reel (37) and water fill pipe (65) are attached to water tank (8).

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Referring to Fig. 2, a vacuum debris tank (12) is mounted at a fixed slope and supported by a water tank (8). A filter housing (62) is mounted on the vacuum debris tank (12). The water tank (8) is mounted on the bed of a truck secured by the goose neck

5 trailer coupler (63) for easy transportation means. Alternative means for easy transportation can also be achieved through mounting the system on a trailer (31, Fig. 3), a skid steer (36, Fig. 4), or a zero turn radius vehicle (31, Fig. 6). The zero turn radius vehicle operates by maneuvering a tilt-away tow hitch and 360 degree swivel front wheels.

10 Referring to Figs. 3 and 8, a vibrated screen (21) may be mounted by flexible connector (68) to the inside of the vacuum debris container access door (18) to separate liquids (2) from the solids (6), which have been vacuumed into the vacuum container (12). Liquids (2) may be piped from the inner part vibrated screen (21), through the access door (18) and into a pump dispensing means (1) strong enough to overcome
15 vacuum within the vacuum container. A liquid conduit (5) recycles the liquid (2) through a liquid purification or sterilization means (74) then back to the water tank (8). The liquid purification or sterilization means (74) may include a hydro cyclone (25), vortex generator, sand filter, activated carbon, zealite, sterilizing elements, filters, ozone, peat, sawdust, shavings, or hydrocarbon absorbing means which may be added in the vacuum
20 container (12) or external to the vacuum container (12) to clean, or sterilize the recycled liquid. A jetter water pump (7) is attached to the water tank (8) and used to pressurize the water to the hose conduit (5).

Referring to Fig. 4, a skid steer (36) can be used for easy mobility of the mounted system as well as providing direct power to the system by connecting the system's engine
25 and vacuum blower power supply (67) to the skid steer's hydraulics.

Referring to Figs. 5-14, a powered, rotating, articulating, telescoping vacuum conduit boom (36) may be mounted onto the vacuum debris tank (12) in order to move

5 the vacuum hose and it's attachments into place for vacuuming at a desired place to vacuum solids or liquids. The vacuum conduit boom (36) may be light weight to only move a vacuum hose or the boom (36) or may be strong enough to support and operate both a telescoping vacuum conduit and a bucket for digging or motorized attachments to pull a vacuum hose into and through a lateral drainage pipe which needs cleaned. The vacuum conduit boom (36) may also have multiple rotating swivel knuckles to aid in directing the vacuum hose into horizontal as well as vertical locations. The vacuum conduit boom (36) may also be equipped with hose reels and means to dispense both vacuum hoses and/or water jetter hoses to a point of use along with their individual attachments, such as jetter nozzles or tractors to pull a hose or operate sensors or digging or cleaning means.

The same boom (36) may have one or more hose reels attached so as to dispense vacuum hose (17), and/or water hose (5), and/or air hose, and/or hydraulic hose, and/or electrical power cords to a desired location for the purpose of vacuuming solids or liquids or making solids or liquids vacuumable, or monitoring or controlling the progress of the vacuuming process, or distributing a power source, for example, to a tractor or jetter nozzle, to pull a hose to a further location. The vacuum hose boom may also have multiple powered articulating arms, elbows, and knuckles to allow it to reach into manholes, or lateral lines leading to or from a manhole, or into silos or storage bins or railcar or tankers.

25 The vacuum conduit boom (36) may be constructed of sufficient strength to support and operate a bucket for digging as needed. The boom may also have quick change end attachments for vacuuming, surface cleaning with water pressure, demolition,

5 grinding, jettering, or preparing surfaces as well as attachments to remove or replace
manhole covers, or monitor or control the operation of attachments or sensors to detect
obstacles or located utilities.

A screw conveyor (10) is used to move solids from the vacuum debris tank (12) to
the solids dispensing telescoping and articulating boom (70) for disposal. The boom (70)
10 could dispose of the solids within the bed of a dump truck (Fig. 10), within a disposal pile
away from the digging site, or any other means necessary. The conveyor (10) may be a
compacting screen conveyor emptying into an air conveyor discharged from a blower
(11) to convey solids.

Referring to Fig. 9, a sensor/monitor may be used in order to detect buried utilities
15 for the purpose of finding the utilities so they can be serviced, or in order to avoid
damage to the utilities. The sensor may be located on the end of an articulating vacuum
conduit boom (36) and be connected to a monitor located near the operator for ease of
viewing. An attachment on the end of the articulating vacuum conduit boom (36) may
include one or more of a water jet, vacuum, cleaning, demolition or sand blasting
20 attachment in order to help in loosening the digging area.

A jetter nozzle (39) may be attached to a jetter hose (58) on the end of a dual
articulating knuckle joint to align the jetter and/or vacuum hose (17) into a lateral
drainpipe or manhole lateral. Water jets (40) on the jetter nozzle (39) are used to propel
debris (45) towards the vacuum hose (17) and to move the jetter nozzle (39) along the
25 drainpipe (38). A vacuum conduit tractor (51) may also be used to clean debris by
clearing debris with an articulating suction head (53) connected to the vacuum conduit

5 (17) and having a vacuum conduit tractor sensor controller (52) to guide the vehicle.

Various other means of clearing the drainpipe (38) could be employed.

A vacuum and water hose reel (54) may be attached (Fig. 11) in order to keep the vacuum and water hose lines clear from kinks or getting tangled in order to provide for an easy means to dispense and retract the various hoses.

10 Referring to Fig. 26, vibrators may be added to the vacuum hose end to loosen hard to vacuum materials such as dry chemicals or elements in cyclones, storage bends, or railcars. Metal may be cleaned and prepared for welding or painting by water pressure. Adding lubricants to the water helps reduce the rust causing effect of using water pressure to remove scale, rust, primers, or paint from metals. Abrasive elements
15 may also be added to the pressurized water to aid in loosening scale, rust, primers, or paint from metal. Once the pressure water loosens the above, the vacuum system described above vacuums the liquid and debris from the steel surface. Heated air under pressure may be blown onto the steel after vacuuming so as to remove remaining water residue. The vacuum/blower unit can double as both the source of vacuum and the source of
20 heated air, since the vacuum producing means heats the air vacuumed from the vacuum container before the air is exhausted. The above described water pressure nozzle jet and vacuum system function as an alternative to using sand blasting as a means to clean and prep metal and clean welds.

Referring to Figs. 27a and 27b, the air entering into or discharged from the
25 combination blower/vacuum producing device may be passed through a muffler to reduce audible sounds conveyed by the blower air. The muffler of choice consists of passing the air through a perforated conduit wrapped with serwool or mineral wool or acoustic

5 absorbing media. A protective outer surface is attached to contain and protect. The
acoustic sound waves are absorbed into the wool or acoustic media. For yet further
sound reduction the air may then be diffused through additional tubes and orifices.

Fig. 28 is a means of using a water header (78) as the outer circumference (80) of
the suction end of a vacuum hose (17). The water header (78) is supplied by a water
10 supply hose (5), which may be placed in parallel proximity to the vacuum hose (17) and
may be articulated by the same vacuum boom. The vacuum hose (17) suction end
circumference water header (77) may have two or more orifices (76) and/or spray nozzles
(82) to distance the water under pressure. A pulsing jet of water is preferred in many
applications. A rotary spray nozzle, jetter nozzle, or air or water pulsing means (82)
15 often reduces water consumption and simultaneously improves mass impact for loosening
or emulsifying items to be vacuumed. A preferred arrangement is to have a vacuum hose
(17) and circumference (80) configured as a water reservoir (77) to supply water to two
or more pulse spray nozzles or jetter nozzles (82) arranged as the circumference (80) of
the vacuum hose (17) suction end. The circumference (80) water reservoir is supplied by
20 a pressure water hose (5) or conduit, a water pump, pressure regulation, controller, and
sensors incorporated within the system.

While particular embodiments of the invention have been shown, it will be
understood, of course, that the invention is not limited thereto since modifications may be
made by those skilled in the art, particularly in light of the foregoing teachings.
25 Reasonable variation and modification are possible within the scope of the foregoing
disclosure of the invention without departing from the spirit of the invention.

5 # DEFINITION

- 1- Dispensing means
- 2- Liquid
- 3- Liquid Discharge conduit from Hydro cyclone 25
- 4- Solids Discharge conduit from Hydro cyclone 25
- 10 5- Discharge conduit from Liquid transfer pump 7
- 6- Solids
- 7- Liquid Transfer pump
- 8- Container to hold dispensed liquids
- 9- Container to hold dispensed solids
- 15 10- Solids dispenser
- 11- Vacuum producing means
- 12- Vacuum container
- 13- Conduit to connect Vacuum container 12- vacuum producing means 11
- 14- Discharge conduit from Vacuum producing means 11
- 20 15- Utility
- 16- Inlet conduit to Hydro cyclone 25
- 17- Vacuum conduit
- 18- End door to Vacuum container 12
- 19- Means to secure end door 18
- 25 20- Hinge for End door 18
- 21- Screen
- 22- Spring on Screen 21

- 5 23- Vibrator
- 24- Support for Springs 22
- 25- Hydro cyclone
- 26- Liquid sprayer
- 27- Grinder
- 10 28- Pivot support for Vacuum container 12
- 29- Cylinder to Raise and Lower Vacuum Container 12
- 30- Wheels on Mobile Platform 31
- 31- Mobile Platform
- 32- Cutting, Demolition, Cleaning and Blasting attachment means
- 15 33- Utility Sensor means
- 34- Monitor and/or Controller
- 35- Ground Surface being dirt, asphalt, stone, or concrete
- 36- Means to Mobilize Vacuum conduit 17 with attachment 32
- 37- Hose Reel
- 20 38- Drain Conduit
- 39- Jetter
- 40- Water Jet
- 41- Means to power the Articulating Vacuum Boom
- 42- Telescoping Vacuum conduit
- 25 43- Digging Bucket
- 44- Structural Means to Support and Articulate Vacuum Conduit
- 45- Debris

- 5 46- Man Hole Cover
- 47- Means to Remove Man Hole Cover such as Electric Magnet, suction,
 mechanical fastener
- 48- Power to Man Hole Cover removal means 47
- 49- Solids Conveyer
- 10 50- Boom Section
- 51- Vacuum conduit Tractor
- 52- Vacuum conduit Tractor Sensor Controller
- 53- Vacuum conduit Tractor Articulating Suction Head
- 54- Vacuum Hose Reel
- 15 55- Purification Elements such as ozone, activated carbon or zealite
- 56- Hydro carbon Absorbing means
- 57- Sterilization means
- 58- Jetter Hose
- 59- Man Hole
- 20 60- Articulating Jetter Boom
- 61- Telescoping Jetter Conduit
- 62- Filter Housing
- 63- Goose Neck Trailer Coupler
- 64- Skid and Lifting Receiver
- 25 65- Fill Pipe to Water Tank
- 66- Inside Debris Tank Center Door Closure Means
- 67- Power Plant

- 5 68- Flexible Connector for Vibrated Screen
- 69- Air Nozzle Orifice to blow and convey solids and convey solids by air
 through the Boom Conduit
- 70- Solids dispensing, telescoping and Articulating Boom
- 71- Air Discharge from Vacuum Blower
- 10 72- Combination Vacuum Hose and Jetter Water Hose articulated Telescoping
 Boom
- 73- Swivel articulated Knuckle Joint to align Jetter and/or Vacuum Hose into a
 lateral line.
- 74- Recycled Water Purification and Sterilization System
- 15 75- Independent Hydraulic Drive Wheels
- 76- Water Jet Orifice
- 77- Water Reservoir Header
- 78- Water Pressure
- 79- Circumference of Vacuum Hose
- 20 80- Circumference of Water Reservoir
- 81- Center of Vacuum Hose
- 82- Pulse or Rotary Jet or Jetter Nozzle
- 83- Hydraulic Power Supply
- 84- Hydraulic Tool and Equipment connection
- 25 85- Hydraulic driven motor or Electric driven motor
- 86- Articulating Boom Arm
- 87- Control system for Drive Motor

- 5 88- Revolution and/or Torque counter for Drive Motor
- 89- .
- 90- GPS (Global Positioning System) to map location of drive motor operation
 such as the location of a valve to be opened or closed or a core sample to be
 taken or a man hole location or repair point location or bored hole location
- 10 91- Adapters for the drive motor such as extensions to reach and connect to valve
 stems or augers.
- 92- Valve with valve stem
- 93- Hose
- 94- Hydrant
- 15 95- Water pressure reducer-diffuser
- 96- Hose Storage
- 97- Liquid such as water from a hydrant
- 98- In ground casing to valve stem
- 99- Bafflers to absorb energy and reduce water pressure
- 20 100- Hitch receiver
- 101- Hitch receiver plugin
- 102- Hitch stabilizing means
- 103- Vehicle plug in power supply
- 104- Power supply for drive motor

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